

**DATA SHEET**

# SKY13455-31: 0.4 to 2.7 GHz SP12T Switch with MIPI RFFE Interface

## Applications

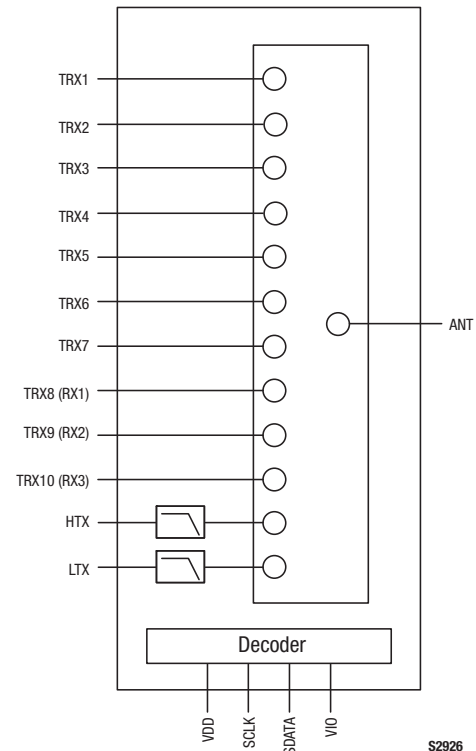
- 2G/3G/4G multimode cellular handsets (LTE, UMTS, CDMA2000, EDGE, GSM)
- Embedded data cards

## Features

- Broadband frequency range: 0.4 to 2.7 GHz
- Low insertion loss
- High isolation and linearity
- Integrated GSM harmonic filter
- Integrated, programmable MIPI interface
- Ten TRX ports, one GSM low band transmit port, and one GSM high band transmit port
- Small MCM (22-pin, 3.2 x 2.5 x 0.8 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.



**Figure 1. SKY13455-31 Block Diagram**

## Description

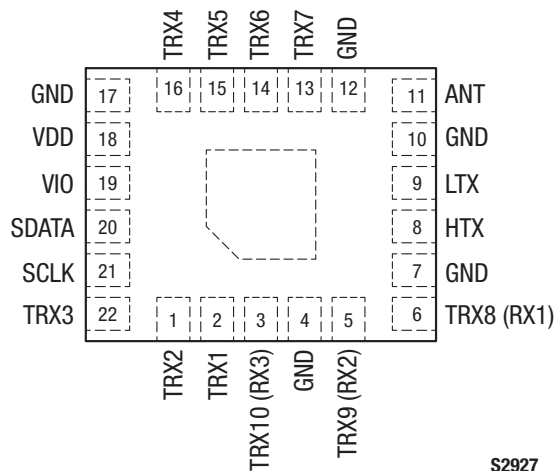
The SKY13455-31 is a Single-Pole, Twelve-Throw (SP12T) antenna switch with integrated GSM transmit harmonic filter. The SKY13455-31 maintains a high linearity, high isolation, and low insertion loss performance, which makes it an ideal choice for UMTS, CDMA2000, EDGE, GSM, and LTE applications.

The design features two dedicated GSM transmit ports. The remaining ten ports are suitable for WCDMA transmit/receive and GSM receive functions. Three transmit ports (TRX1, TRX2, and TRX4) have been specifically designed to provide optimal LTE Band 13 performance. The switch exhibits an excellent triple beat ratio and 2<sup>nd</sup>/3<sup>rd</sup> order modulation distortion performance.

Switching is controlled by an integrated MIPI interface. Depending on the logic applied to the decoder, the antenna pin is connected to one of 12 switched RF ports using a low insertion loss path, while the paths between the antenna pin and the other RF pins are in a high isolation state. No external DC blocking capacitors are required on the RF paths.

The SKY13455-31 is manufactured in a compact, 3.2 x 2.5 x 0.8 mm, 22-pin surface mount Multi-Chip Module (MCM) package.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.



**Figure 2. SKY13455-31 Pinout – 22-Pin MCM  
(Top View)**

**Table 1. SKY13455-31 Signal Descriptions**

| Pin # | Name        | Description                                                          | Pin # | Name  | Description                                                       |
|-------|-------------|----------------------------------------------------------------------|-------|-------|-------------------------------------------------------------------|
| 1     | TRX2        | RF input/output port 2 optimized for LTE Band 13 (704 to 787 MHz)    | 12    | GND   | Ground                                                            |
| 2     | TRX1        | RF input/output port 1 optimized for LTE Band 13 (704 to 787 MHz)    | 13    | TRX7  | RF input/output port 7                                            |
| 3     | TRX10 (RX3) | RF input/output port 10 (receive 3)                                  | 14    | TRX6  | RF input/output port 6                                            |
| 4     | GND         | Ground                                                               | 15    | TRX5  | RF input/output port 5                                            |
| 5     | TRX9 (RX2)  | RF input/output port 9 (receive 2)                                   | 16    | TRX4  | RF input/output port 4 optimized for LTE Band 13 (704 to 787 MHz) |
| 6     | TRX8 (RX1)  | RF input/output port 8 (receive 1)                                   | 17    | GND   | Ground                                                            |
| 7     | GND         | Ground                                                               | 18    | VDD   | DC power supply                                                   |
| 8     | HTX         | GSM high band transmit RF input port with integrated harmonic filter | 19    | VIO   | Interface supply voltage                                          |
| 9     | LTX         | GSM low band transmit RF input port with integrated harmonic filter  | 20    | SDATA | Data                                                              |
| 10    | GND         | Ground                                                               | 21    | SCLK  | Clock                                                             |
| 11    | ANT         | Antenna RF port                                                      | 22    | TRX3  | RF input/output port 3                                            |

**Note:** Bottom ground paddles must be connected to ground.

**Table 2. SKY13455-31 Absolute Maximum Ratings**

| Parameter              | Symbol | Minimum | Maximum | Units |
|------------------------|--------|---------|---------|-------|
| Power supply           | VDD    | 2.5     | 5.0     | V     |
| Digital control signal | VIO    |         | 2       | V     |
| RF input power:        | PIN    |         |         |       |
| LTX pin                |        |         | +36     | dBm   |
| HTX pin                |        |         | +34     | dBm   |
| All TRXx pins          |        |         | +31     | dBm   |
| Storage temperature    | TSTG   | –55     | +150    | °C    |
| Operating temperature  | TOP    | –30     | +90     | °C    |

**Note:** Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

**CAUTION:** Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13455-31 are provided in Table 2. Electrical specifications are provided in Tables 3, 4, and 5. Figure 3 shows a timing diagram for the SKY13455-31.

IMD2 and IMD3 test conditions for various frequencies are listed in Tables 6 and 7, respectively.

Figure 4 illustrates the test setup used to measure intermodulation products. This industry standardized test is used to simulate the WCDMA Band 1 linearity of the antenna switch. A +20 dBm Continuous Wave (CW) signal,  $f_{\text{FUND}}$ , is sequentially applied to the TRX1 through TRX10 ports, while a –15 dBm CW blocker signal,  $f_{\text{BLK}}$ , is applied to the ANT port.

The resulting 3<sup>rd</sup> Order Intermodulation Distortion (IMD3),  $f_{\text{RX}}$ , is measured over all phases of  $f_{\text{FUND}}$ . The SKY13455-31 exhibits exceptional performance for all TRXx ports.

Table 8 describes the register content and programming read/write sequences. Refer to the *MIPI Alliance Specification for RF Front-End Control Interface (RFFE)*, v1.10 (26 July 2011) for additional information on MIPI programming sequences and MIPI bus specifications.

Figures 5 and 6 provide the timing diagrams for register write commands and read commands, respectively.

Table 9 provides the Register\_0 logic. Table 10 describes the register parameters and bit values.

**Table 3. SKY13455-31 Electrical Specifications (Note 1) (1 of 4)****(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter                | Symbol | Test Condition            | Min | Typical | Max  | Units |
|--------------------------|--------|---------------------------|-----|---------|------|-------|
| <b>RF Specifications</b> |        |                           |     |         |      |       |
| Insertion loss:          | IL     |                           |     |         |      |       |
| TXLB                     |        | 824 to 915 MHz, +35 dBm   |     | 1.25    | 1.45 | dB    |
| TXHB                     |        | 1710 to 1910 MHz, +33 dBm |     | 1.15    | 1.35 | dB    |
| TRX1/2/4                 |        | 704 to 787 MHz, +25 dBm   |     | 0.55    | 0.70 | dB    |
| TRX3/5 to 10             |        | 704 to 787 MHz, +25 dBm   |     | 0.65    | 0.80 | dB    |
| TRX1/2/3                 |        | 824 to 960 MHz, +25 dBm   |     | 0.60    | 0.75 | dB    |
| TRX4/5/6/7               |        | 824 to 960 MHz, +25 dBm   |     | 0.70    | 0.85 | dB    |
| TRX8/9/10                |        | 824 to 960 MHz, +25 dBm   |     | 0.60    | 0.75 | dB    |
| TRX1/2/3                 |        | 1710 to 1990 Mhz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX4/5/6/7               |        | 1710 to 1990 Mhz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX8/9/10                |        | 1710 to 1990 Mhz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX1/2/3                 |        | 2110 to 2170 MHz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX4/5/6/7               |        | 2110 to 2170 MHz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX8,9,10                |        | 2110 to 2170 MHz, +25 dBm |     | 0.70    | 0.85 | dB    |
| TRX1/2/3                 |        | 2300 to 2690 MHz, +25 dBm |     | 0.75    | 0.90 | dB    |
| TRX4/5/6                 |        | 2300 to 2690 MHz, +25 dBm |     | 0.95    | 1.10 | dB    |
| TRX7                     |        | 2300 to 2690 MHz, +25 dBm |     | 1.10    | 1.30 | dB    |
| TRX8/9/10                |        | 2300 to 2690 MHz, +25 dBm |     | 0.75    | 0.95 | dB    |

**Table 3. SKY13455-31 Electrical Specifications (Note 1) (2 of 4)****(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter                                      | Symbol   | Test Condition                                                             | Min | Typical | Max | Units |
|------------------------------------------------|----------|----------------------------------------------------------------------------|-----|---------|-----|-------|
| <b>RF Specifications (continued)</b>           |          |                                                                            |     |         |     |       |
| Return loss                                    | VSWR     | TRXx ports, 0.4 to 2.2 GHz                                                 | 14  | 18      |     | dB    |
| GSM harmonic attenuation                       | H2LB     | Transmit low band to ANT, 2fo 1648 to 1830 MHz                             | 25  | 28      |     | dB    |
|                                                | H3LB     | Transmit low band to ANT, 3fo 2472 to 2745 MHz                             | 25  | 28      |     | dB    |
|                                                | H4LB     | Transmit low band to ANT, 4fo 3296 to 3660 MHz                             |     | 25      |     | dB    |
|                                                | H2HB     | Transmit high band to ANT, 2fo 3420 to 3820 MHz                            |     | 25      |     | dB    |
|                                                | H3HB     | Transmit high band to ANT, 3fo 5130 to 5730 MHz                            | 25  | 28      |     | dB    |
| Large signal harmonics, transmit GSM low band  | 2fo, 3fo | Transmit GSM low band, P <sub>IN</sub> <+34.5 dBm, VSWR = 1:1              |     | −54     | −45 | dBm   |
|                                                | 2fo, 3fo | Transmit GSM low band, P <sub>IN</sub> <+34.5 dBm, VSWR = 5:1, all phases  |     | −40     | −36 | dBm   |
| Large signal harmonics, transmit GSM high band | 2fo, 3fo | Transmit GSM high band, P <sub>IN</sub> <+33 dBm, VSWR = 1:1               |     | −54     | −45 | dBm   |
|                                                | 2fo, 3fo | Transmit GSM high band, P <sub>IN</sub> <+33 dBm, VSWR = 5:1, all phases   |     | −40     | −36 | dBm   |
| Large signal harmonics, I transmit band 13     | 2fo      | ANT to TRXx ports, @ 777 to 787 MHz, P <sub>IN</sub> < +25 dBm, VSWR = 1:1 |     | −78     |     | dBm   |
| Large signal harmonics, transmit band 17       | 3fo      | ANT to TRXx ports, @ 704 to 716 MHz, P <sub>IN</sub> ≤ +25 dBm, VSWR = 1:1 |     | −80     | −78 | dBm   |
| Large signal harmonics, TRXx                   | 2fo, 3fo | Transmit WCDMA 824 to 915 MHz, P <sub>IN</sub> <+27 dBm, VSWR = 1:1        |     | −72     | −66 | dBm   |
|                                                | 2fo, 3fo | Transmit WCDMA 824 to 915 MHz, P <sub>IN</sub> <+27 dBm, VSWR = 5:1        |     | −57     | −45 | dBm   |

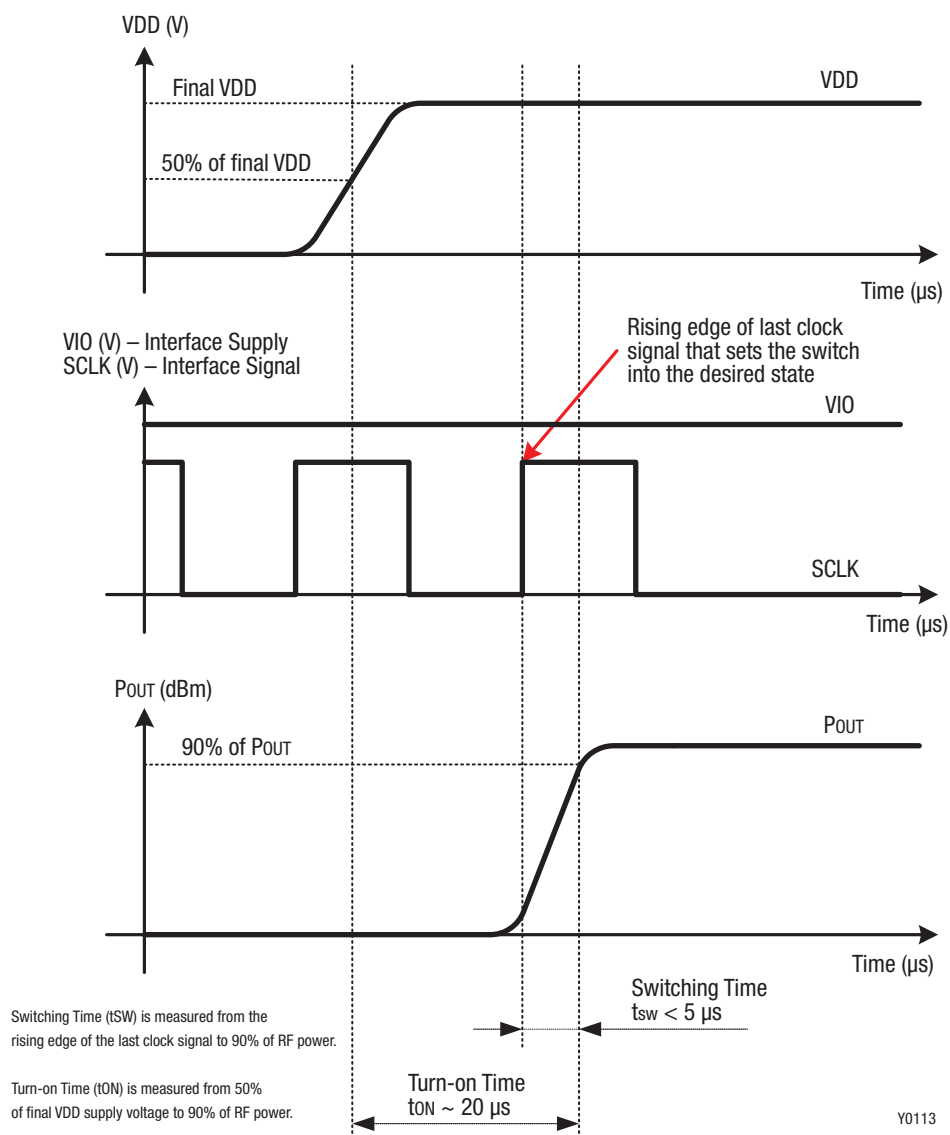
**Table 3. SKY13455-31 Electrical Specifications (Note 1) (3 of 4)****(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter                                                        | Symbol           | Test Condition                                                                                   | Min | Typical | Max | Units |
|------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------|-----|---------|-----|-------|
| <b>RF Specifications (continued)</b>                             |                  |                                                                                                  |     |         |     |       |
| Large signal harmonics, TRXx                                     | 2fo, 3fo         | Transmit WCDMA 1710 to 1980 MHz, P <sub>IN</sub> <+27 dBm, VSWR = 1:1, all phases                |     | -67     | -60 | dBm   |
|                                                                  | 2fo, 3fo         | Transmit WCDMA 1710 to 1980 MHz, P <sub>IN</sub> <+27 dBm, VSWR = 5:1, all phases                |     | -57     | -45 | dBm   |
| Isolation (full isolation “on” arms to “off” arms) (see Table 5) | Iso_TX1/2_1800   | LTX to HTX,<br>P <sub>IN</sub> <+35 dBm,<br>@ 1648 to 1830 MHz                                   | 28  | 30.5    |     | dB    |
|                                                                  | Iso_TX1/TRX_900  | LTX to TRXx pins,<br>P <sub>IN</sub> <+35 dBm,<br>@ 824 to 915 MHz                               | 37  | 40      |     | dB    |
|                                                                  | Iso_TX1/RX_900   | LTX to receive ports<br>(Note 2),<br>P <sub>IN</sub> <+35 dBm,<br>@ 869 to 960 MHz               | 35  | 43      |     | dB    |
|                                                                  | Iso_TX2/TRX_1800 | HTX to TRXx pins,<br>P <sub>IN</sub> <+33 dBm,<br>@ 1710 to 1910 MHz                             | 32  | 35      |     | dB    |
|                                                                  | Iso_RX2/RX3_1990 | TRX9 (RX2) to ANT when<br>TRX10 (RX3) active,<br>P <sub>IN</sub> <+27 dBm,<br>@ 1805 to 1990 MHz | 31  | 34      |     | dB    |
|                                                                  | Iso_RX3/RX2_1990 | TRX10 (RX3) to ANT when<br>TRX9 (RX2) active,<br>P <sub>IN</sub> <+27 dBm,<br>@ 1805 to 1990 MHz | 31  | 34      |     | dB    |
|                                                                  | Iso_TRX/RX       | TRXx to receive ports<br>(Note 2),<br>P <sub>IN</sub> <+27 dBm,<br>@ 1710 to 1910 MHz            | 25  | 27      |     | dB    |
|                                                                  | Iso_TRX/TRX      | TRXx to TRXx,<br>P <sub>IN</sub> <+27 dBm,<br>@ 824 to 1910 MHz,<br>every other pin              | 26  | 29      |     | dB    |
|                                                                  | Iso_TRX/TRX      | TRXx to TRXx,<br>P <sub>IN</sub> <+27 dBm,<br>@ 824 to 1910 MHz,<br>opposite side pins           | 40  | 43      |     | dB    |
|                                                                  | Iso_TRX/TRX      | TRXx to TRXx,<br>P <sub>IN</sub> <+27 dBm,<br>@ 824 to 1910 MHz,<br>adjacent pins                | 20  | 22      |     | dB    |

**Table 3. SKY13455-31 Electrical Specifications (Note 1) (4 of 4)****(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter                                                 | Symbol          | Test Condition                                        | Min                        | Typical | Max                                           | Units        |
|-----------------------------------------------------------|-----------------|-------------------------------------------------------|----------------------------|---------|-----------------------------------------------|--------------|
| <b>DC Specifications</b>                                  |                 |                                                       |                            |         |                                               |              |
| Triple Beat Ratio (see Table 4)                           | TBR             | 650 to 900 MHz                                        | +81                        | +91     |                                               | dBc          |
|                                                           |                 | 1710 to 2155 MHz                                      | +81                        | +92     |                                               | dBc          |
| 2nd Order Intermodulation Distortion                      | IMD2            | See Table 5                                           |                            | −110    | −105                                          | dBm          |
| 3rd Order Intermodulation Distortion                      | IMD3            | See Table 6                                           |                            | −110    | −105                                          | dBm          |
| Supply voltage                                            | V <sub>DD</sub> |                                                       | 2.50                       | 2.85    | 3.30                                          | V            |
| Supply current                                            | I <sub>DD</sub> |                                                       |                            | 35      | 100                                           | μA           |
| Digital data and clock signals:<br>High<br>Low<br>Current | SDATA, SCLK     |                                                       | 0.8 × V <sub>IO</sub><br>0 |         | V <sub>IO</sub><br>0.2 × V <sub>IO</sub><br>5 | V<br>V<br>μA |
| Interface supply voltage level                            | V <sub>IO</sub> |                                                       | 1.65                       | 1.80    | 1.95                                          | V            |
| DC supply turn-on/turn-off time (Note 3)                  |                 |                                                       |                            |         | 20                                            | μs           |
| RF path switching time (Note 3)                           |                 | Between the ANT port and either LTX/HTX or TRXx ports |                            | 2       | 5                                             | μs           |
| Supply ripple                                             |                 |                                                       |                            |         | 20                                            | mVp-p        |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.**Note 2:** Dedicated receive ports are TRX8 (RX1), TRX9 (RX2), or TRX10 (RX3).**Note 3:** Refer to Figure 3.

**Figure 3. SKY13455-31 Timing Diagram****Table 4. Triple Beat Ratio Frequencies and Power Levels**

| Band | Transmit Frequency 1 (MHz) | Transmit Power 1 (dBm) | Transmit Frequency 2 (MHz) | Transmit Power 2 (dBm) | Frequency Blocker ANT (MHz) | Power Blocker (dBm) | Triple Beat Product Frequency (MHz) |
|------|----------------------------|------------------------|----------------------------|------------------------|-----------------------------|---------------------|-------------------------------------|
| 2    | 1880.0                     | +21.5                  | 1881.0                     | +21.5                  | 1960.0                      | -30                 | $1960.0 \pm 1$                      |
| 5    | 836.5                      | +21.5                  | 881.5                      | +21.5                  | 881.5                       | -30                 | $881.5 \pm 1$                       |

**Table 5. SKY13455-31 Electrical Specifications: Isolation, “On” Arms to “Off” Arms (Note 1)**  
**(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| “On” Arm | Freq (MHz) | Isolation (dB) |     |      |      |      |      |      |      |      |      |      |       |
|----------|------------|----------------|-----|------|------|------|------|------|------|------|------|------|-------|
|          |            | LTX            | HTX | TRX1 | TRX2 | TRX3 | TRX4 | TRX5 | TRX6 | TRX7 | TRX8 | TRX9 | TRX10 |
| LTX      | 915        | –              | –26 | –51  | –52  | –54  | –56  | –52  | –47  | –46  | –43  | –48  | –51   |
| HTX      | 1910       | –25            | –   | –43  | –43  | –45  | –44  | –43  | –40  | –39  | –33  | –39  | –43   |
| TRX1     | 915        | –34            | –66 | –    | –27  | –34  | –56  | –56  | –50  | –51  | –50  | –43  | –32   |
| TRX1     | 1910       | –37            | –45 | –    | –22  | –28  | –45  | –45  | –42  | –41  | –43  | –37  | –27   |
| TRX1     | 2690       | –36            | –38 | –    | –19  | –25  | –39  | –41  | –39  | –37  | –38  | –34  | –24   |
| TRX2     | 915        | –34            | –64 | –30  | –    | –28  | –53  | –57  | –51  | –51  | –52  | –45  | –38   |
| TRX2     | 1910       | –37            | –44 | –24  | –    | –23  | –44  | –45  | –42  | –41  | –44  | –39  | –33   |
| TRX2     | 2690       | –36            | –37 | –21  | –    | –20  | –38  | –41  | –39  | –37  | –39  | –36  | –30   |
| TRX3     | 915        | –34            | –62 | –34  | –31  | –    | –50  | –57  | –52  | –52  | –54  | –47  | –41   |
| TRX3     | 1910       | –37            | –44 | –29  | –26  | –    | –42  | –45  | –42  | –41  | –45  | –41  | –36   |
| TRX3     | 2690       | –36            | –37 | –26  | –22  | –    | –37  | –39  | –39  | –37  | –40  | –37  | –33   |
| TRX4     | 915        | –34            | –57 | –49  | –48  | –47  | –    | –28  | –36  | –41  | –60  | –55  | –52   |
| TRX4     | 1910       | –37            | –43 | –43  | –42  | –42  | –    | –22  | –30  | –33  | –47  | –47  | –45   |
| TRX4     | 2690       | –36            | –37 | –39  | –38  | –38  | –    | –19  | –26  | –28  | –42  | –42  | –41   |
| TRX5     | 915        | –35            | –55 | –50  | –49  | –49  | –30  | –    | –29  | –37  | –59  | –55  | –52   |
| TRX5     | 1910       | –38            | –43 | –44  | –43  | –43  | –25  | –    | –23  | –30  | –47  | –47  | –45   |
| TRX5     | 2690       | –36            | –37 | –40  | –39  | –39  | –21  | –    | –19  | –26  | –42  | –42  | –41   |
| TRX6     | 915        | –35            | –53 | –51  | –50  | –50  | –36  | –31  | –    | –30  | –58  | –55  | –52   |
| TRX6     | 1910       | –38            | –42 | –44  | –43  | –44  | –30  | –25  | –    | –23  | –46  | –47  | –45   |
| TRX6     | 2690       | –36            | –37 | –40  | –39  | –40  | –26  | –22  | –    | –20  | –41  | –42  | –41   |
| TRX7     | 915        | –37            | –51 | –51  | –50  | –51  | –39  | –38  | –32  | –    | –56  | –54  | –52   |
| TRX7     | 1910       | –39            | –42 | –44  | –43  | –44  | –32  | –31  | –26  | –    | –45  | –46  | –45   |
| TRX7     | 2690       | –35            | –38 | –40  | –39  | –40  | –28  | –27  | –22  | –    | –40  | –41  | –41   |
| TRX8     | 915        | –34            | –37 | –42  | –44  | –46  | –58  | –55  | –50  | –51  | –    | –29  | –37   |
| TRX8     | 1910       | –42            | –29 | –37  | –39  | –41  | –45  | –45  | –42  | –41  | –    | –24  | –31   |
| TRX8     | 2690       | –35            | –27 | –34  | –35  | –37  | –40  | –42  | –39  | –37  | –    | –21  | –28   |
| TRX9     | 915        | –34            | –54 | –39  | –42  | –44  | –59  | –54  | –49  | –51  | –36  | –    | –32   |
| TRX9     | 1910       | –40            | –42 | –34  | –37  | –39  | –45  | –45  | –42  | –41  | –29  | –    | –27   |
| TRX9     | 2690       | –36            | –39 | –31  | –34  | –36  | –40  | –42  | –39  | –37  | –25  | –    | –24   |
| TRX10    | 915        | –34            | –65 | –29  | –36  | –40  | –58  | –55  | –49  | –51  | –44  | –38  | –     |
| TRX10    | 1910       | –38            | –45 | –24  | –31  | –35  | –45  | –45  | –42  | –41  | –36  | –32  | –     |
| TRX10    | 2690       | –36            | –39 | –21  | –28  | –32  | –40  | –42  | –39  | –37  | –32  | –29  | –     |

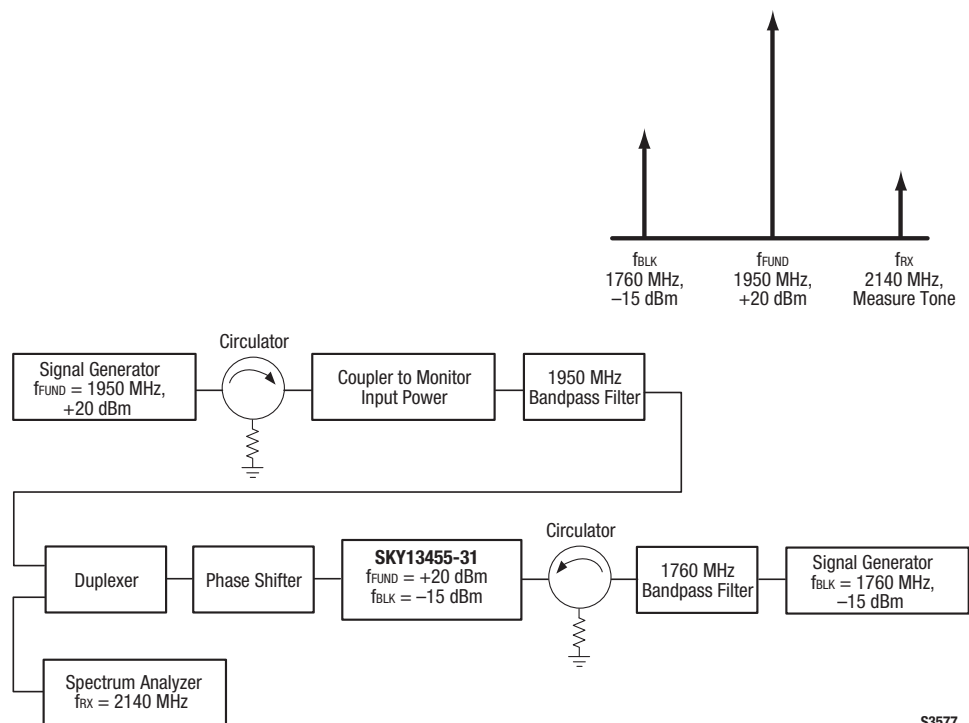
**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

**Table 6. IMD2 Test Conditions**

| Band | Transmit Frequency (MHz) | Transmit Power (dBm) | Frequency Blocker, Low (MHz) | Frequency Blocker, High (MHz) | Power Blocker (dBm) | Receive Frequency (MHz) |
|------|--------------------------|----------------------|------------------------------|-------------------------------|---------------------|-------------------------|
| 1    | 1950.0                   | +20                  | 190                          | 4090                          | -15                 | 2140.0                  |
| 2    | 1880.0                   |                      | 80                           | 3840                          |                     | 1960.0                  |
| 4    | 1732.0                   |                      | 400                          | 3864                          |                     | 2132.0                  |
| 5    | 836.5                    |                      | 45                           | 1718                          |                     | 881.5                   |
| 7    | 2535.0                   |                      | 120                          | 5187                          |                     | 2655.0                  |
| 8    | 897.0                    |                      | 45                           | 1839                          |                     | 942.0                   |

**Table 7. IMD3 Test Conditions**

| Band | Transmit Frequency (MHz) | Transmit Power (dBm) | Frequency Blocker (MHz) | Power Blocker (dBm) | Receive Frequency (MHz) |
|------|--------------------------|----------------------|-------------------------|---------------------|-------------------------|
| 1    | 1950.0                   | +20                  | 1760.0                  | -15                 | 2140.0                  |
| 2    | 1880.0                   |                      | 1800.0                  |                     | 1960.0                  |
| 4    | 1732.0                   |                      | 1332.0                  |                     | 2132.0                  |
| 5    | 836.5                    |                      | 791.5                   |                     | 881.5                   |
| 7    | 2535.0                   |                      | 2415.0                  |                     | 2655.0                  |
| 8    | 897.0                    |                      | 852.0                   |                     | 942.0                   |



S3577

**Figure 4. 3<sup>rd</sup> Order Intermodulation Test Setup**

**Table 8. Command Sequence Bit Definitions**

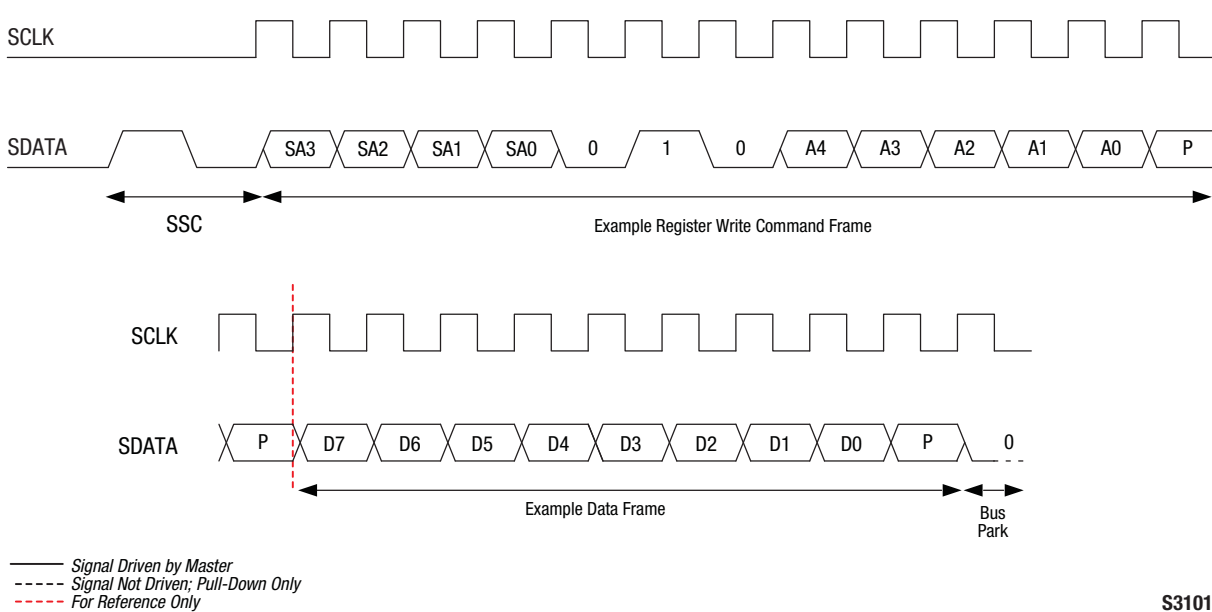
| Type       | SSC | C11-C8  | C7 | C6-C5     | C4      | C3-C0     | Parity Bits | BPC | Extended Operation |             |     |               |             |     |
|------------|-----|---------|----|-----------|---------|-----------|-------------|-----|--------------------|-------------|-----|---------------|-------------|-----|
|            |     |         |    |           |         |           |             |     | DA7(1)-DA0(1)      | Parity Bits | BPC | DA7(n)-DA0(n) | Parity Bits | BPC |
| Reg0 Write | Y   | SA[3:0] | 1  | Data[6:5] | Data[4] | Data[3:0] | Y           | Y   | —                  | —           | —   | —             | —           | —   |
| Reg Write  | Y   | SA[3:0] | 0  | 10        | Addr[4] | Addr[3:0] | Y           | —   | Data[7:0]          | —           | —   | —             | Y           | Y   |
| Reg Read   | Y   | SA[3:0] | 0  | 11        | Addr[4] | Addr[3:0] | Y           | Y   | Data[7:0]          | —           | —   | —             | Y           | Y   |

**Legend:**

SSC = Sequence start command  
C = Command frame bits

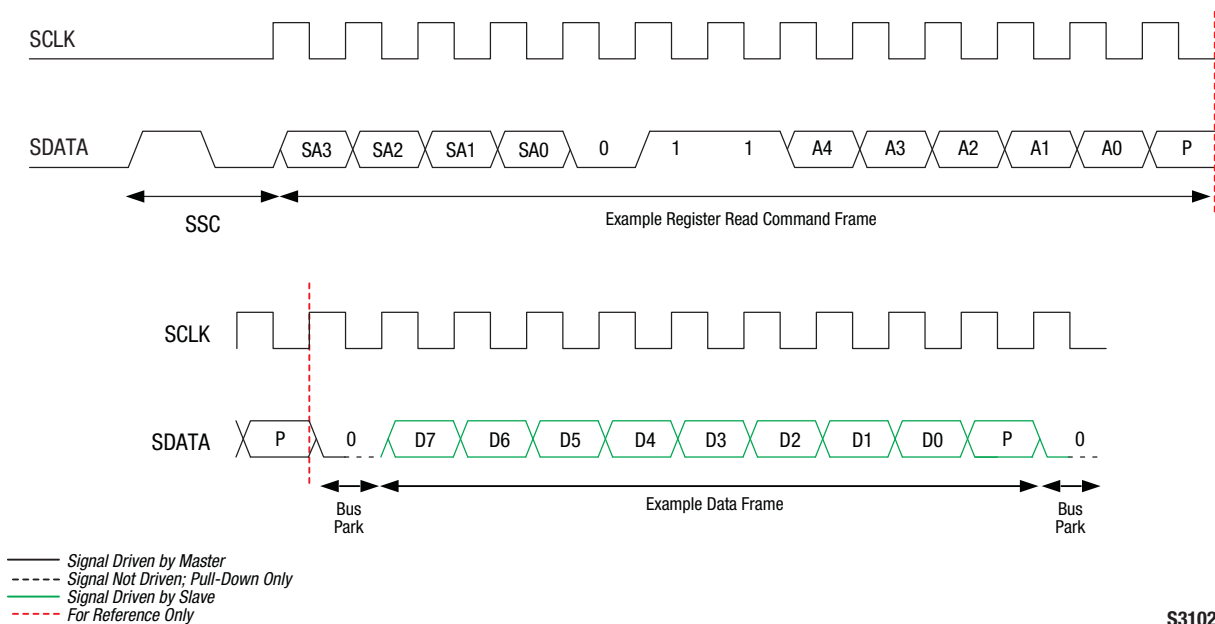
DA = Data/address frame bits  
BPC = Bus park cycle

BC = Byte count (# of consecutive addresses)



S3101

**Figure 5. Register Write Command Timing Diagram**



S3102

Figure 6. Register Read Command Timing Diagram

Table 9. Register\_0 Truth Table

| State | Mode              | Register 0 Bits |    |    |    |    |    |    |    |
|-------|-------------------|-----------------|----|----|----|----|----|----|----|
|       |                   | D7              | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 1     | Sleep             | x               | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 2     | LTX               | x               | 0  | 0  | 0  | 1  | 0  | 1  | 0  |
| 3     | HTX               | x               | 0  | 0  | 0  | 1  | 0  | 0  | 0  |
| 4     | TRX1              | x               | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| 5     | TRX2              | x               | 0  | 0  | 0  | 0  | 1  | 0  | 1  |
| 6     | TRX3              | x               | 0  | 0  | 0  | 0  | 1  | 1  | 0  |
| 7     | TRX4              | x               | 0  | 0  | 0  | 0  | 1  | 1  | 1  |
| 8     | TRX5              | x               | 0  | 0  | 0  | 1  | 0  | 0  | 1  |
| 9     | TRX6              | x               | 0  | 0  | 0  | 1  | 0  | 1  | 1  |
| 10    | TRX7              | x               | 0  | 0  | 0  | 1  | 1  | 0  | 0  |
| 11    | TRX8              | x               | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 12    | TRX9              | x               | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| 13    | TRX10             | x               | 0  | 0  | 0  | 0  | 0  | 1  | 1  |
| 14    | TRX3 + TRX4       | x               | 0  | 0  | 0  | 1  | 1  | 0  | 1  |
| 15    | TRX5 + TRX10      | x               | 0  | 0  | 0  | 1  | 1  | 1  | 0  |
| 16    | Warmup (optional) | x               | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

**Table 10. Register Description and Programming (1 of 2)**

| Register    |                  | Parameter                | Description                                                                                                                                                | Default<br>(Binary) |
|-------------|------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Name        | Address<br>(Hex) |                          |                                                                                                                                                            |                     |
| Register_0  | 0000             | MODE_CTRL                | Bits[7:0]:<br>Switch control. See Table 8 for logic                                                                                                        | –                   |
| RFFE_STATUS | 001A             | SOFTWARE RESET           | Bit[7]:<br>Resets all data to default values except for USID, GSID, or the contents of the PM_TRIG Register.<br>0 = Normal operation<br>1 = Software reset | 0                   |
|             |                  | COMMAND_FRAME_PARITY_ERR | Bit[6]:<br>Command sequence received with parity error – discard command.                                                                                  | 0                   |
|             |                  | COMMAND_LENGTH_ERR       | Bit[5]:<br>Command length error.                                                                                                                           | 0                   |
|             |                  | ADDRESS_FRAME_PARITY_ERR | Bit[4]:<br>Address frame parity error = 1.                                                                                                                 | 0                   |
|             |                  | DATA_FRAME_PARITY_ERR    | Bit[3]:<br>Data frame with parity error.                                                                                                                   | 0                   |
|             |                  | READ_UNUSED_REG          | Bit[2]:<br>Read command to an invalid address.                                                                                                             | 0                   |
|             |                  | WRITE_UNUSED_REG         | Bit[1]:<br>Write command to an invalid address.                                                                                                            | 0                   |
|             |                  | BID_GID_ERR              | Bit[0]:<br>Read command with a BROADCAST_ID (refer to the <i>MIPI Alliance Specification</i> ) or GSID.                                                    | 0                   |
| GROUP_SID   | 001B             | Reserved                 | Bits[7:4]: Reserved                                                                                                                                        | 0000                |
|             |                  | GSID                     | Bits[3:0]:<br>Group slave ID                                                                                                                               | 0000                |

**Table 10. Register Description and Programming (2 of 2)**

| Register            |               | Parameter       | Description                                                                                                                                                                                             | Default (Binary) |
|---------------------|---------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Name                | Address (Hex) |                 |                                                                                                                                                                                                         |                  |
| PM_TRIG<br>(Note 1) | 001C          | PWR_MODE        | Bits[7:6]:<br>00 = Normal operation (active)<br>01 = Default settings (startup)<br>10 = Low power (low power)<br>11 = Reserved                                                                          | 00               |
|                     |               | Trigger_Mask_2  | Bit[5]:<br>If this bit is set, trigger 2 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 2, the data goes directly to the destination register.   | 0                |
|                     |               | Trigger_Mask_1  | Bit[4]:<br>If this bit is set, trigger 1 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 1, the data goes directly to the destination register.   | 0                |
|                     |               | Trigger_Mask_0  | Bit[3]:<br>If this bit is set, trigger 0 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 0, the data goes directly to the destination register.   | 0                |
|                     |               | Trigger_2       | Bit[2]:<br>If this bit is set, data is loaded into the trigger 2 registers.                                                                                                                             | 0                |
|                     |               | Trigger_1       | Bit[1]:<br>If this bit is set, data is loaded into the trigger 1 registers (unsupported).                                                                                                               | 0                |
|                     |               | Trigger_0       | Bit[0]:<br>If this bit is set, data is loaded into the trigger 0 registers (unsupported).                                                                                                               | 0                |
| PRODUCT_ID          | 001D          | PRODUCT_ID      | Bits[7:0]:<br>This is a read-only register. However, during the programming of the Unique Slave Identifier (USID), a write command sequence is performed on this register but the value is not changed. | 01000001         |
| MANUFACTURER_ID     | 001E          | MANUFACTURER_ID | Bits[7:0]:<br>Read-only register                                                                                                                                                                        | 10100101         |
| MAN_USID            | 001F          | Reserved        | Bits[7:6]:<br>Reserved                                                                                                                                                                                  | 00               |
|                     |               | MANUFACTURER_ID | Bits[5:4]:<br>Read-only register                                                                                                                                                                        | 01               |
|                     |               | USID            | Bits[3:0]:<br>Programmable USID. A write to these bits programs the USID.                                                                                                                               | 1011             |

**Note 1:** Unlike the complete independence between triggers 0, 1, and 2, and also between the associated trigger masks 0, 1, and 2, respectively, as described in the MIPI RFFE Specification, this device uses additional interactions between the provided trigger functions.

The delayed application of updated data to all triggerable registers in this device can be accomplished using any of the three triggers (0, 1, or 2), provided that the particular trigger used is not currently masked off. If multiple triggers are enabled, any or all of those are sufficient to cause the data to be transferred from shadow registers to destination registers for all triggerable registers in the device.

It is also necessary to disable all three triggers (i.e., set all three trigger masks) to ensure that data written to any triggerable register is immediately written to the destination register at the conclusion of the RFFE command sequence where the data is written.

## Evaluation Board Description

The SKY13455-31 Evaluation Board is used to test the performance of the SKY13455-31 SP12T Switch. An Evaluation Board schematic diagram is provided in Figure 7. A recommended ESD protection circuit diagram is provided in Figure 8. An assembly drawing for the Evaluation Board is shown in Figure 9.

## Package Dimensions

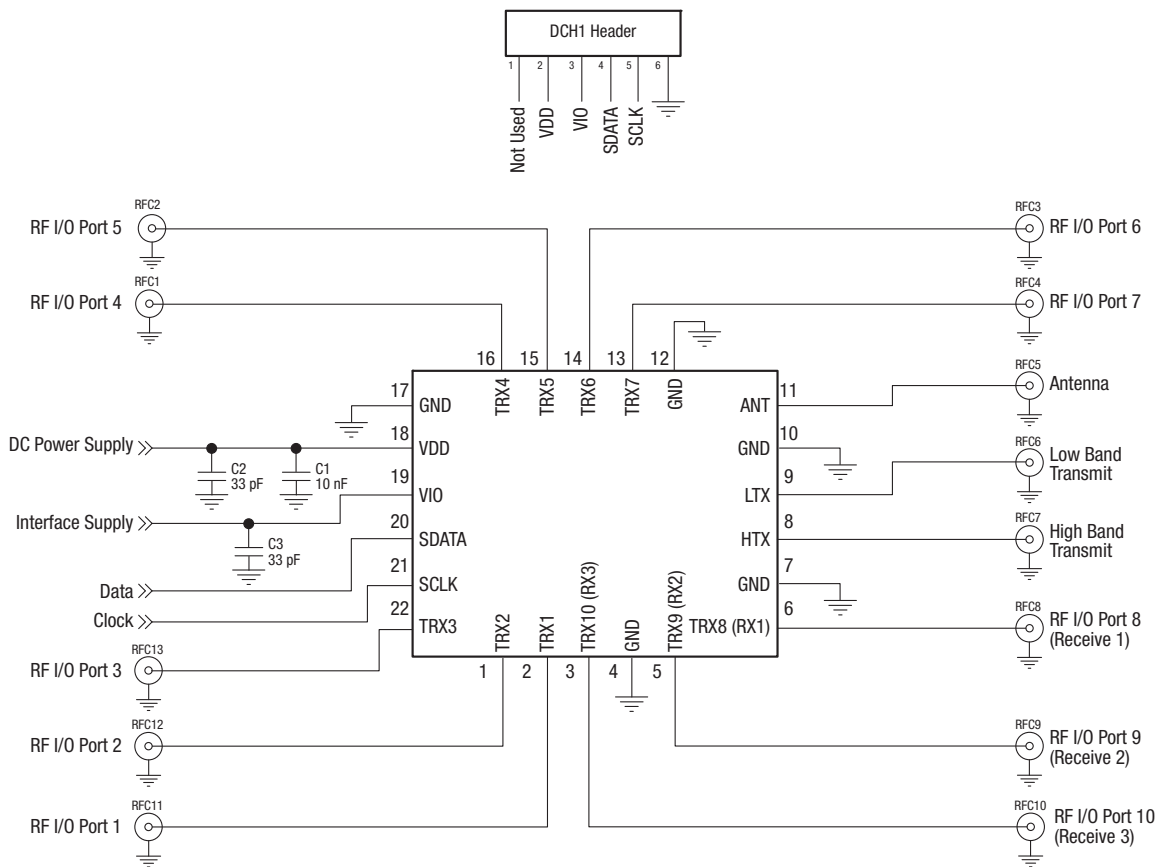
The PCB layout footprint for the SKY13455-31 is provided in Figure 10. Typical case markings are shown in Figure 11. Package dimensions for the 22-pin MCM are shown in Figure 12, and tape and reel dimensions are provided in Figure 13.

## Package and Handling Information

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

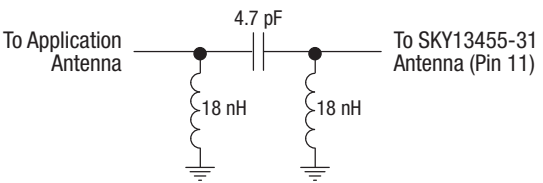
The SKY13455-31 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design and SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

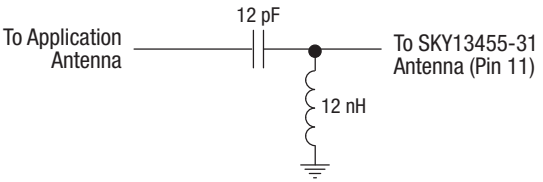


S3320

**Figure 7. SKY13455-31 Evaluation Board Schematic**



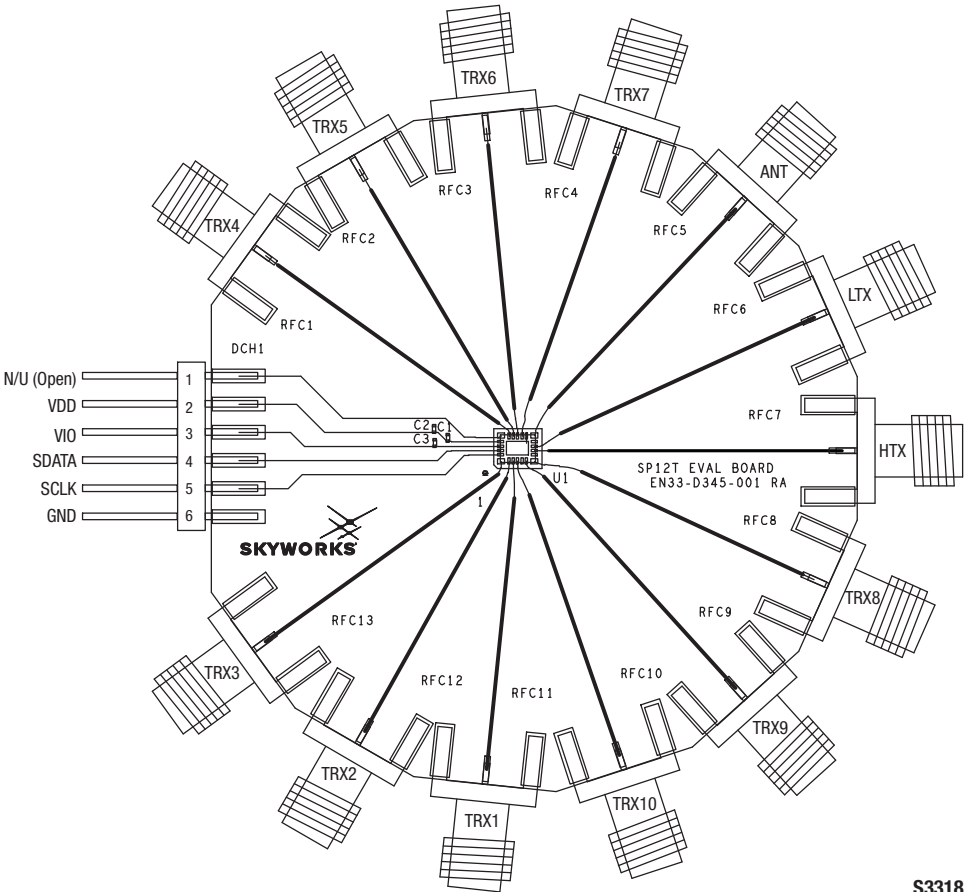
ESD Circuit 1



ESD Circuit 2

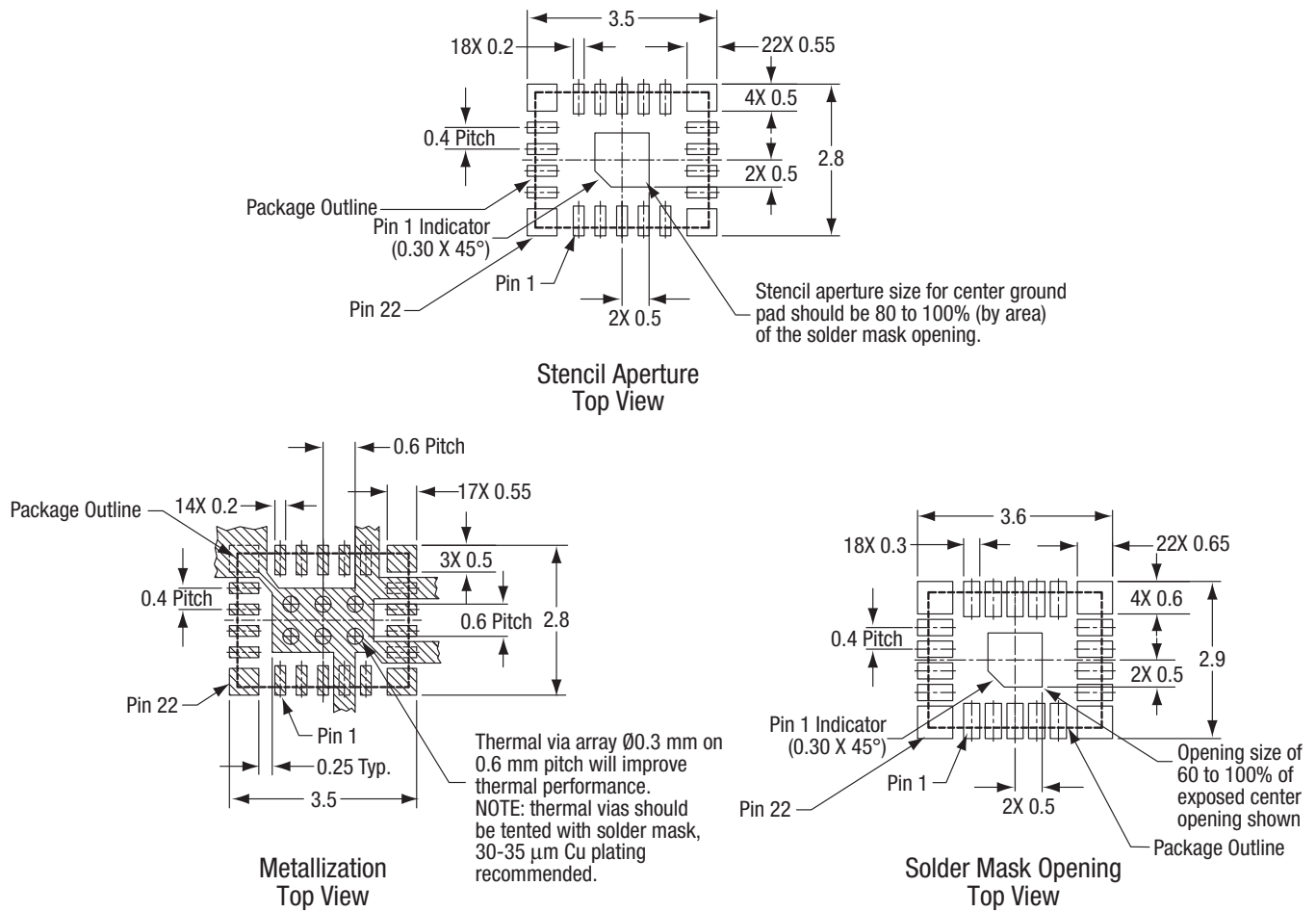
S3578

Figure 8. SKY13455-31 Recommended ESD Protection Circuits



S3318

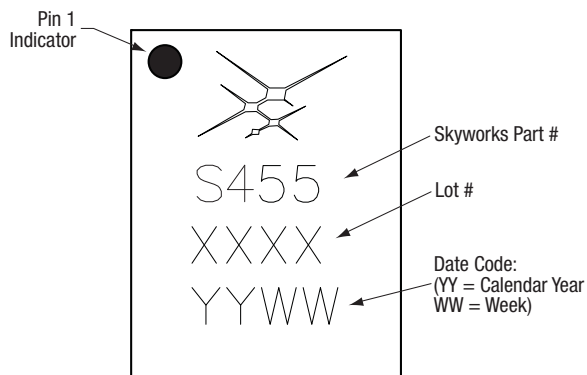
Figure 9. SKY13455-31 Evaluation Board Assembly Diagram



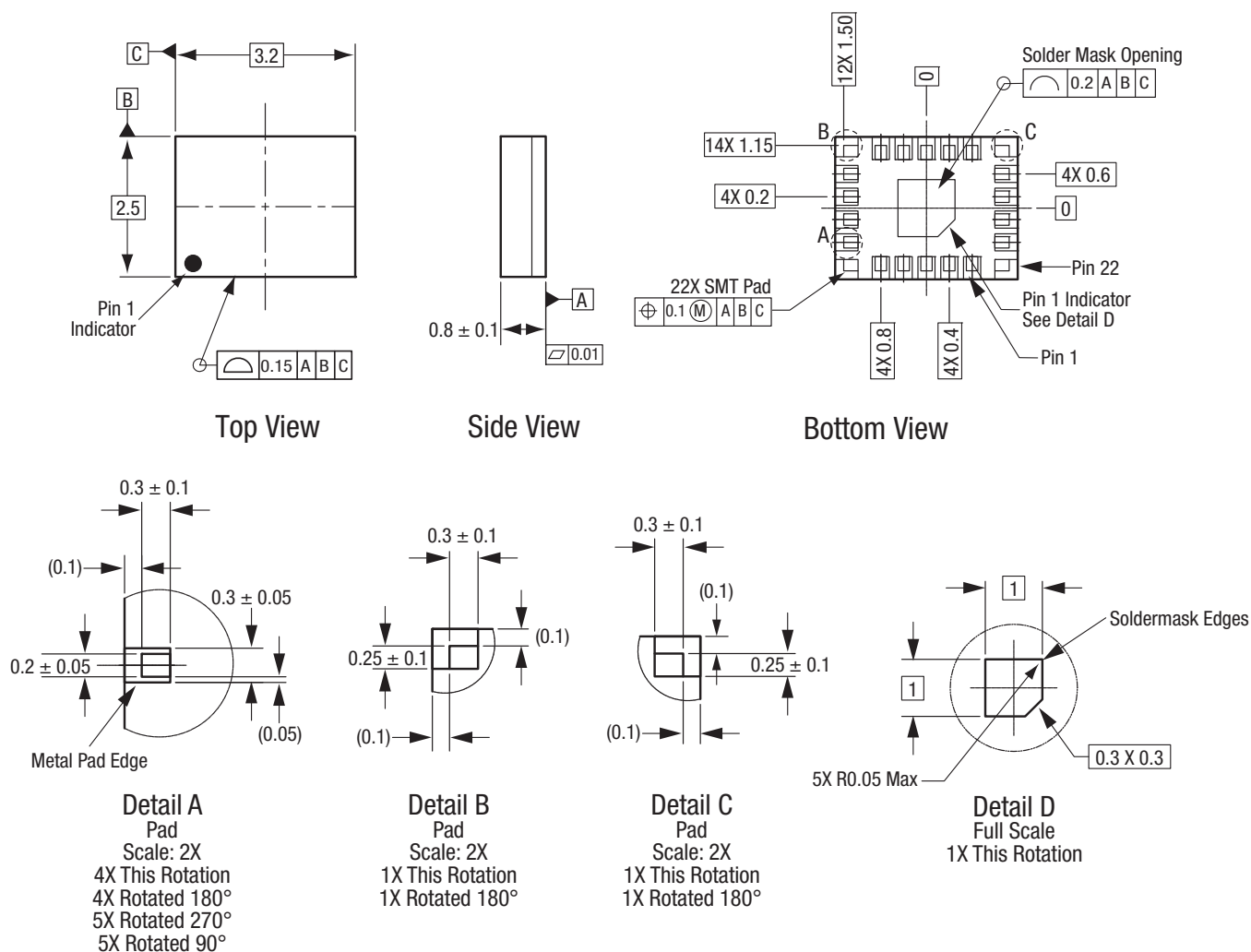
All dimensions are in millimeters

S3319

**Figure 10. SKY13455-31 PCB Layout Footprint**



**Figure 11. Typical Part Markings (Top View)**



All measurements are in millimeters

Dimensioning and tolerancing according to ASME Y14.5M-1994

S3579

**Figure 12. SKY13455-31 22-Pin MCM Package Dimensions**



## Ordering Information

| Model Name                                                    | Manufacturing Part Number | Evaluation Board Part Number |
|---------------------------------------------------------------|---------------------------|------------------------------|
| SKY13455-31 0.4-2.7 GHz SP12T Switch with MIPI RFFE Interface | SKY13455-31               | SKY13455-31-EVB              |

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